**IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION**

RAMOT AT TEL AVIV UNIVERSITY LTD., Plaintiff, v. CISCO SYSTEMS, INC., Defendant.	CIVIL ACTION NO. 2:22-cv-00168 **JURY TRIAL DEMANDED**

COMPLAINT FOR PATENT INFRINGEMENT

1. Plaintiff Ramot at Tel Aviv University, Ltd. ("Ramot") files this complaint for Patent Infringement against Cisco Systems, Inc. ("Cisco"), requests a trial by jury, and alleges as follows upon actual knowledge with respect to itself and its own acts and upon information and belief as to all other matters.

NATURE OF ACTION

2. This is an action for patent infringement. Ramot alleges that Cisco infringes U.S. Patent No. 11,342,998 ("the '998 patent" or the "Asserted Patent"), a copy of which is attached hereto as Exhibit A.[1]

[1] Because the PDF of the patent is not yet available from the USPTO, Exhibit A includes the issue information, as-issued claims, and originally filed specification, taken from the prosecution history of the '998 Patent.

3. Ramot alleges that Cisco directly and indirectly infringes the Asserted Patent by making, using, offering for sale, selling and importing optical networking transceiver modules and line cards, and components thereof, providing advanced electro-optical modulation techniques—including, without limitation, certain of Cisco's and subsidiary Acacia's various optical networking modules, line cards, and associated circuitry and software. Ramot further alleges that Cisco induces and contributes to the infringement of others. Ramot further alleges that Cisco's infringement is willful. Ramot seeks damages and other relief for Cisco's infringement of the Asserted Patent.

PARTIES

4. Ramot is a limited liability company organized under the laws of Israel with its principal place of business at Tel Aviv University, Senate Building at Gate no. 4, George Wise Street, Tel Aviv, Israel.

5. Ramot is the Business Engagement Center of Tel Aviv University ("TAU") and acts as the University's liaison to industry. Ramot connects cutting-edge promising innovations at the University with the global commercial marketplace through collaboration with industry partners around the world as well as the formation of new companies. TAU was founded in 1956 and is the largest academic and research institution in the State of Israel. It is the most multidisciplinary with many young scientists that graduated from some of the leading research institutions around the world, which resulted in accomplishing the third highest position among the EU scientific community for the young scientist category. Ramot provides the resources, as well as the business and legal frameworks for inventions made by TAU's faculty, students, and researchers, protecting the discoveries with IP and working jointly with industry and the venture community to bring scientific innovations to the global markets.

6. Ramot manages a portfolio of more than 5000 patents and patent applications worldwide. This number represents hundreds of distinct technology families of which more than 30 percent are already commercialized to multi-national companies as well as newly founded companies. Ramot is the owner of more than 600 granted patents of which more than 400 are United States patents.

7. Ramot is the assignee and owner of the Asserted Patent. The Asserted Patent is based on and claims the inventions of Dr. Yossef Ehrlichman, Dr. Amrani Ofer, and Professor Shlomo Ruschin. Each of the inventors was affiliated with TAU's School of Electrical Engineering during the relevant time period of the inventions, and assigned his rights to the Asserted Patent to Ramot.

8. On information and belief, Defendant Cisco is a Delaware corporation with its principal place of business at 170 West Tasman Drive, San Jose, California 95134.

9. On information and belief, Acacia Communications, Inc. ("Acacia") is a wholly-owned subsidiary of Cisco. Cisco completed its acquisition of Acacia on March 1, 2021 for a sum of $4.5 billion dollars.

10. Cisco is registered to do business in the State of Texas.

11. On information and belief, Cisco maintains places of business and does business in Texas and in the Eastern District of Texas, *inter alia*, at its campus at 2250 East President George Bush Turnpike, Richardson, Texas 75082, and at its data center at 2260 Chelsea Blvd., Allen, Texas 75013. Cisco's Richardson and Allen facilities were appraised and taxed together by the Collin County Appraisal District at a combined value of over $300,000,000.

12. By registering to conduct business in Texas and by having facilities where it regularly conducts business in this District, Defendant has a permanent and continuous presence in Texas and a regular and established place of business in the Eastern District of Texas.

JURISDICTION AND VENUE

13. This is an action arising under the patent laws of the United States, 35 U.S.C. § 271, *et seq*. Accordingly, this Court has subject matter jurisdiction pursuant to 28 U.S.C. §§ 1331 and 1338(a).

14. This Court has personal jurisdiction over Cisco due, *inter alia*, to its continuous presence in, and systematic contact with, this judicial district and its registration in Texas and domicile in this judicial district. Cisco is subject to this Court's jurisdiction pursuant to due process and/or the Texas Long Arm Statute due at least to its substantial business in this State and judicial district, including at least part of its past infringing activities, regularly doing or soliciting business at its Richardson and Allen facilities, and engaging in persistent conduct and/or deriving substantial revenue from goods and services provided to customers in the State of Texas, including in the Eastern District of Texas. Cisco directly and/or through subsidiaries or intermediaries (including distributors, retailers, and others), has committed and continues to commit acts of infringement in this judicial district by, among other things, making, using, importing, offering for sale, and/or selling products and/or services that infringe the Asserted Patent.

15. Venue is proper in this judicial district pursuant to 28 U.S.C. §§1391(b), (c), (d) and 1400(b) because Cisco has a permanent and continuous presence in, has committed acts of infringement in, and maintains a regular and established place of business in this district. Upon information and belief, Cisco has committed acts of direct and indirect infringement in this

judicial district, including using and purposefully transacting business involving the Accused Products in this judicial district such as by sales to one or more customers in the State of Texas, including in the Eastern District of Texas, and maintains regular and established places of business in this judicial district, as set forth above.

FACTUAL ALLEGATIONS

Ramot Patents

16. Ramot is the Business Engagement Center at Tel Aviv University, Israel's foremost research and teaching university. Ramot's mission is to foster, initiate, lead and manage the transfer of new technologies from the laboratory to the marketplace. Ramot helps commercialize promising scientific discoveries by providing the resources, business, Intellectual Property, and legal framework for researchers—creating successful business connections between Tel Aviv University's scientists and researchers, and technology companies ranging from startups to Fortune 500 companies.

17. Since 1999, Ramot has helped found more than 130 technology startup companies. Within the area of electronics and electro-optics, Ramot is currently affiliated with over 70 accomplished researchers who are developing dozens of distinct cutting-edge technologies. Ramot owns hundreds of granted patents worldwide that span various fields of technology.

18. Co-Inventor Dr. Yossef Ehrlichman, received the B.Sc.(EE) and MBA degrees from the Technion, Haifa, Israel, in 1999 and 2002, respectively. He received the M.Sc.(EE) and Ph.D. degrees from Tel Aviv University, Tel Aviv, Israel, in 2007 and 2015, respectively. During his Ph.D., he worked on photonic integrated mixed signal circuits, such as photonic digital-to-analog and analog-to-digital converters. He co-invented a direct digital drive method

which allows the integration of digital CMOS circuits with photonic integrated modulators. Between 2013-2015 he worked as a Radiometry Engineer at SemiConductor Devices (SCD), Israel, developing advanced cooled-IR detectors. Between 2015-2017 he held a position of a Postdoctoral Research Associate at the University of Colorado Boulder investigating silicon photonics devices and circuits for RF photonics applications. Between 2017-2018 he held a position of Postdoctoral Researcher at University of California San Diego, continuing his research on silicon photonic devices and circuits for RF photonics applications. Since 2018 he is a Senior Member of the Technical Staff at Axalume, San Diego, CA, developing silicon-photonics hybrid lasers, and electronics-photonics circuits for data centers. Dr. Ehrlichman is a senior member of the IEEE.

19. Co-Inventor Dr. Ofer Amrani is faculty at Tel Aviv University's School of Electrical Engineering, Tel Aviv, Israel. He received the Ph.D. degree in Electrical Engineering with honors from Tel Aviv University in November 2000. In 1999 he co-founded CUTE-systems and served as its CTO. In October 2001 he joined Tel Aviv University in the department of Electrical Engineering-Systems. In 2006 he was a visiting scientist at the Dept. of Electrical Engineering, Technion-Israel Institute of Technology. Since 2007 he has been with Tel Aviv University as a senior lecturer. His main research interests include various aspects of digital communications; as well as optical components and new transistor architectures for interfacing between electronic and optical signals. Dr. Amrani currently heads the Tel-Aviv University nano-satellite laboratory and led the development, construction, and recent successful launch of the University's first orbiting research satellite. Since 1994 he has been consulting to various industrial companies.

20. Co-Inventor and Professor Shlomo Ruschin received the B.Sc. degree in Physics and Mathematics from the Hebrew University in Jerusalem in 1969. He continued his graduate studies at the Technion-Israel Institute of Technology in Haifa where he specialized in the fields of Lasers and Quantum Optics. He received the M.Sc. degree in 1973 and the D.Sc. in 1977. During the period 1978-79 he completed Postdoctoral studies at Cornell University where he was involved in the research of laser diagnostics of molecules and bistability effects. In 1980, Dr. Ruschin joined the Department of Physical Electronics at the Faculty of Engineering of Tel Aviv University, where he presently is Professor Emeritus of Electrical Engineering. During the years 2013-2018 he was Incumbent of the Chana and Heinrich Manderman Chair in Optoelectronics. His fields of research include Laser Physics and electro-optics, and he presently leads the Photonic Devices group at the University. The group is dedicated to various aspects of theory and practice of wave guided devices for optical communication and sensing. Other topics of his research interest are the shaping of coherent beams, and near-field optics. He published more than 165 articles in reviewed periodicals in subjects related to quantum optics, electro-optics, and lasers. In 2001, Shlomo Ruschin co-founded ColorChip Inc., a company marketing integrated optics components and high-speed optical transceivers for data centers. During 1995-1999, Prof. Ruschin acted as Head of the Department of Electrical Engineering-Physical Electronics at Tel Aviv University.

21. The Asserted Patent, entitled "Linearized Optical Digital-to-Analog Modulator," was duly and lawfully issued on May 24, 2022. Ramot is the owner of all right, title, and interest in the Asserted Patent. A true and correct copy of the Asserted Patent is attached hereto as Exhibit A.

22. The Asserted Patent describes problems and shortcomings in the field of optical modulators for converting high speed digital data into modulated optical signals, and claims novel and inventive technological improvements and solutions to such problems and shortcomings.

23. For example, the Asserted Patent discloses and claims methods for performing advanced modulation techniques that meet the need for "high-performance and large bandwidth" signal conversion for multi-GHz communication systems. In one aspect of the invention, the disclosed and claimed features enable actuating a plurality of electrodes using multiple actuating voltage levels so as to modulate the optical signal according to a QAM (Quadrature Amplitude Modulation) modulation scheme. In another aspect of the invention, the disclosed and claimed features enable using a digital mapping of symbols to pre-equalize or compensate for known signal degradations—such as the non-linear response of modulator components.

24. For example, the Asserted patent explains that Mach-Zehnder Interferometer modulators used in fiber-optic communications applications exhibited serious problems at higher speeds due to the "inherent non-linear response of the modulator." The Asserted patent discloses and claims solutions to this problem that "offer improved linearity of response without sacrificing efficiency or dynamic range." In one aspect of the invention, the disclosed and claimed features enable digital mapping of data bits to voltage values, suitable for driving modulator electrodes or for being coupled indirectly to the modulator (such as through a driver circuit or digital to analog converter), so as to select the actuation pattern that best models a desired optical signal output for a given digital input. In this and other disclosed aspects of the invention, the mapping function, in combination with the disclosed and claimed advanced

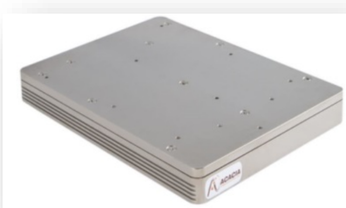
modulation techniques, enables multi-GHz optical communication with improved speed, clarity, and/or linearity.

CISCO'S USE OF THE PATENTED TECHNOLOGY

A. Acacia Optical Transceiver Modules and DSP Chips

25. On information and belief, Cisco makes, uses, sells, and/or offers to sell in the United States, and/or imports into the United States—through its wholly owned subsidiary, Acacia Communications, Inc.—various coherent optical transceiver modules, as well as major components of such modules such as its Acacia Digital Signal Processing ("DSP") application specific integrated circuits ("ASICs") and Silicon Photonic integrated circuits ("ICs") suitable for use by others in building infringing optical transceiver modules. For example, Acacia makes, uses, and sells embedded and pluggable coherent optical transceiver modules (and components thereof), for use in cloud datacenter interconnect, high-speed metro, long-haul, and submarine optical networks, as well as in several optical access network applications. *See, e.g.*, Applications, *available at* https://acacia-inc.com/applications/.

26. Acacia's coherent optical transceiver modules include embedded or pluggable "Multi-Haul Modules" such as the AC1200, AC400, and CIM 8 products, as well as 100G, 200G, and 400G pluggable modules in a variety of standard form factors such as CFP-DCO, CFP2-DCO, CFP2-ACO, OSFP, and QSFP-DD. *See, e.g.*, Products, *available at* https://acacia-inc.com/products/.




27. Acacia also sells multiple generations of its DSP ASICs and Silicon Photonic ICs as standalone products. *See, e.g.*, Products, *available at* https://acacia-inc.com/products/. Acacia's customers can buy embedded or pluggable modules as a complete solution, or can "buy the DSP directly from Acacia and integrate them directly on their linecards using an Acacia-provided reference design." *See, e.g.*, DSP ASIC Products, *available at* https://acacia-inc.com/product/dsp-asic-products/. Acacia's customers can also buy the Silicon Photonic ICs used in Acacia's modules as a separate component, to be "Coupled with Acacia's DSP ASIC" in their own linecard designs. *See, e.g.*, *available at* https://acacia-inc.com/product/silicon-photonic-integrated-circuits-pic/.

28. Acacia's coherent optical transceiver modules (and components thereof) operate at speeds of 100Gbps or higher per optical wavelength. *See, e.g.*, Product Portfolio: Powering High Speed Communications at 100G and Beyond, *available at* https://acacia-inc.com/wp-content/uploads/2018/08/Acacia-Product-Portfolio-BRO-073118-v11-WEB.pdf. Acacia's products include modules that transmit as much as 1.2Tbps on a single wavelength. *See, e.g.*, Blog: "Introducing the AC1200-SC^2 Coherent 1.2T Single-Chip, Single-Channel Module," *available at* https://acacia-inc.com/blog/introducing-the-ac1200-sc2-coherent-1-2t-single-chip-single-channel-module/.

29. Each of Acacia's currently offered coherent optical transceiver modules employ advanced modulation techniques such as Quadrature Amplitude Modulation (QAM) with

modulation constellations ranging from 4 (QPSK) to as many as 64 (64QAM) points. *See, e.g.*, Acacia Unveils Industry's First Single Carrier 1.2T Multi-Haul Pluggable Module, *available at* https://acacia-inc.com/blog/acacia-unveils-industrys-first-single-carrier-1-2t-multi-haul-pluggable-module/ ("delivering 1.2T per carrier capacity for high-capacity DCI interfaces and 800G per carrier capacity over most optical links using 4 bits/symbol (~16QAM) modulation"); Product Portfolio at 3 (AC200 CFP2-DCO Product Family: "With support for 100 Gbps using QPSK modulation and 200 Gbps using either 8QAM or 16QAM, the module offers enhanced flexibility in a pluggable coherent solution"); Whitepaper, "Network Optimization in the 600G Era," *available at* https://acacia-inc.com/acacia-resources/white-paper-network-optimization-in-the-600g-era/ ("The AC1200 uses a dual-core modem design to drive two tunable 600G C-band or L-band wavelengths from one DSP device for a total transmission capacity of 1.2Tb per module up to 64QAM"); QSFP DD Product Family, *available at* https://acacia-inc.com/product/qsfp-dd-product-family/ (400ZR QSFP-DD Pluggable Coherent Optical Module: "reaches up to 120km using 16QAM transmission"); Press Release, Acacia Communications Announces the Industry's First Coherent Flex-rate 400G 5×7 Transceiver Module ("The new AC-400 is the first Flex-Rate 400G Coherent 5×7 Transceiver Module supporting the most advanced modulation modes including 8QAM, 16QAM and QPSK"); Press Release, Acacia Communications Industry-First Coherent AC100-CFP Now Generally Available and Shipping in Volumes ("enabling single wavelength coherent 100G PM-QPSK in a CFP form factor"); Press Release, Acacia Communications Introduces CFP2-ACO Module Based on Its Silicon PIC ("Acacia's CFP2-ACO is capable of supporting both 100G DP-QPSK and 200G DP-16QAM modulation"); *see also* H. Zhang, *et al.*, Real-time transmission of 16 Tb/s over 1020km using 200Gb/s CFP2-DCO, Optics Express, Vol. 26, No. 16, Mar. 19, 2018 at Fig. 2:

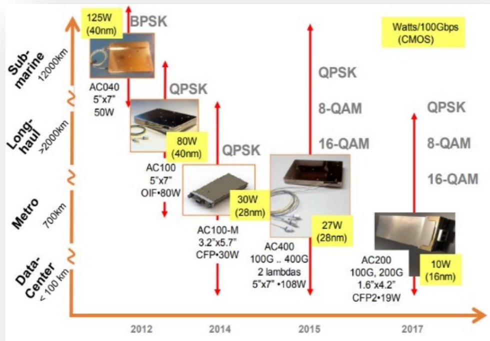


Fig. 2. Evolution in power and density per 100Gbps for coherent transceiver modules.

30. With the exception of Acacia's CFP2-ACO modules, each of Acacia's currently offered coherent optical transceiver modules employ one or more instances of one of Acacia's various generations of DSP ASIC, integrated into the module. *See, e.g.*, Coherent Interconnect Module 8, *available at* https://acacia-inc.com/product/coherent-interconnect-module-8/ ("Powered by Jannu, our 8th-generation digital signal processor (DSP) ASIC"); OSFP Product Family, *available at* https://acacia-inc.com/product/osfp-product-family/ ("The 400G OSFP product family is based on our Greylock 7nm DSP"); QSFP-DD Product Family, *available at* https://acacia-inc.com/product/qsfp-dd-product-family/ ("based on our 7nm DSP technology"); AC1200 Product Family, *available at* https://acacia-inc.com/product/ac1200/ ("based on our Pico digital signal processor (DSP) ASIC"); CFP2-DCO Product Family, *available at* https://acacia-inc.com/product/cfp2-dco/, ("incorporates Acacia's Meru DSP ASIC"); AC400 Flex Product Family, *available at* https://acacia-inc.com/product/ac400-flex/ ("based on our Denali DSP"); *see also* Whitepaper, "Network Optimization in the 600G Era," *available at* https://acacia-inc.com/acacia-resources/white-paper-network-optimization-in-the-600g-era/ at Figure 7:

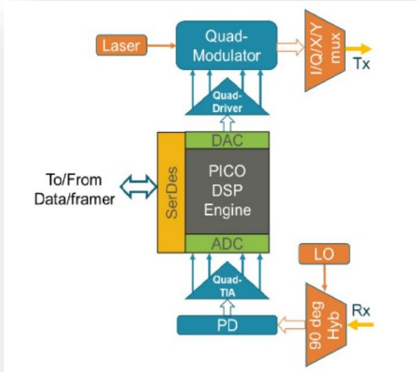
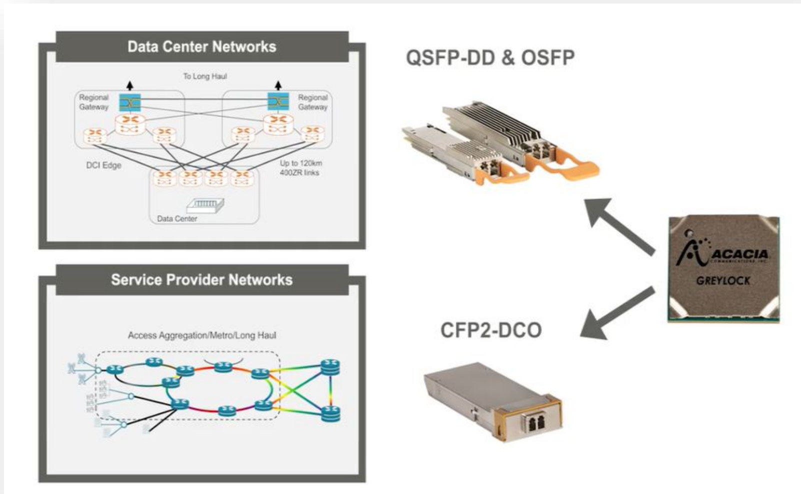


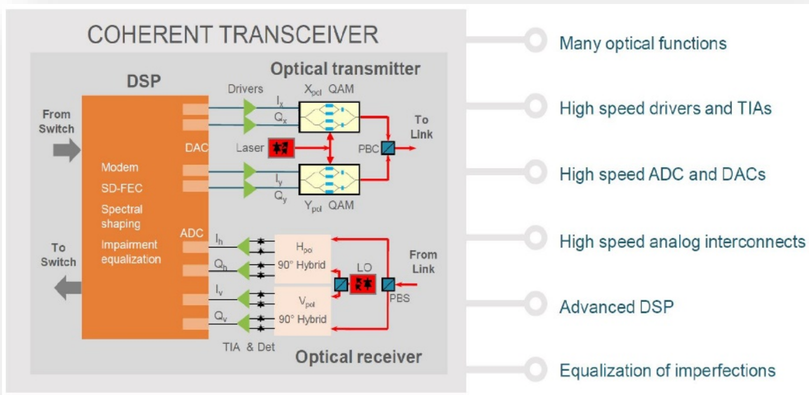
Figure 7. AC1200 simple block diagram. Shared local oscillator (LO) and Tx laser.

31. For example, Acacia's line of 400Gbps pluggable modules in OSFP, QSFP-DD, and CFP2-DCO form factors use Acacia's latest generation of DSP ASIC and Silicon Photonic ICs to address an important application for high-speed coherent optical links in data center interconnect and at the access edge of service provider networks. *See, e.g.*, Blog, 400G Pluggables Usher in an Architectural Change to High-Bandwidth DCI, *available at* https://acacia-inc.com/blog/400g-pluggables-usher-in-an-architectural-change-to-high-bandwidth-dci/ ("Acacia's new 400G pluggable modules are based on its Greylock 7nm DSP"); Video, The New Era of 400G Coherent Pluggable Solutions, *available at* https://acacia-inc.com/acacia-resources/the-new-era-of-400g-coherent-pluggable-solutions/:



32. The digital mapping technologies of the Asserted Patent, as practiced by Acacia's DSP ASICs, are an enabling technology for these 400Gbps coherent transmission applications. *See, e.g.*, Presentation, Coherent Solutions Evolving Toward Edge and Access Applications, Optinet 2020, Aug. 27, 2020 at 8, *available at* https://acacia-inc.com/wp-content/uploads/2020/08/Optinet-2020_Coherent-Solutions-Evolving-Towards-Edge-and-Access-Applications_Acacia.pdf (listing "Electrical compensations" for "impairments" from, *inter alia*, "Components" among motivators for use of 400 Gbps coherent in Edge/Access applications); Whitepaper, 400ZR: Accessible 400G for Edge DCIs and Beyond, at 5, *available at* https://acacia-inc.com/wp-content/uploads/2019/07/400ZR-Market-Backgrounder_June2019-FINAL1.pdf ("However, advances in CMOS, integrated optics, coherent digital signal processor (DSP) designs, as well as DSP coding and equalization algorithms, have significantly reduced the power and size of coherent interfaces for edge DCI applications while maintaining a high level of performance"); Presentation, Coherent Optical Solutions for Data Center Interconnect, Optinet 2019, June 13, 2019, at 8, *available at* https://acacia-inc.com/wp-content/uploads/2019/06/Optinet-China-2019_Acacia_Fenghai-Liu_UpLoad_v1.pdf ("Efficient

EQ for non-perfect optics"), 6 ("Spectral shaping" and "Impairment equalization" in "Advanced DSP" for "Equalization of imperfections"):



33. Use of digital mapping for "compensating linear and non-linear impairments" is also among the important, performance-enhancing features Acacia advertises with respect to its newest DSP chips and latest transceiver modules. *See, e.g.*, Coherent Interconnect Module 8, *available at* https://acacia-inc.com/product/coherent-interconnect-module-8/ ("The Jannu DSP includes Acacia's advanced line-rate power-efficient processing algorithms to efficiently overcome fiber transmission impairments over greenfield or brownfield fiber infrastructures by compensating linear and non-linear impairments").

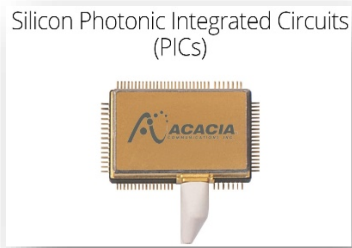
34. Acacia participates in, and advertises that its modules are interoperable with, a number of industry working group standards and implementation agreements. For example, Acacia participated in, and advertises that its 400G pluggable modules are interoperable with, the OIF 400ZR Implementation Agreement. *See, e.g.*, QSFP-DD Product Family ("Acacia's 400Gbps 400ZR QSFP-DD coherent optical module is designed to adhere to the Optical Internetworking Forum (OIF) 400ZR Implementation Agreement"); CFP2-DCO Product Family ("Acacia's 400Gbps CFP2-DCO coherent optical module is designed with adherence to

OpenROADM, OpenZR+, OIF 400ZR, as well as CableLabs specifications”); *see also* Optical Interface Forum, Implementation Agreement 400ZR, OIF-400ZR-01.0, March 10, 2020 at 99, *available at* https://www.oiforum.com/wp-content/uploads/OIF-400ZR-01.0_reduced2.pdf.

35. Acacia’s CFP2-ACO module is designed to be used with an external DSP ASIC on a linecard. *See, e.g.*, CFP2-ACO Product Family, *available at* https://acacia-inc.com/product/cfp2/. It can be used in this configuration with Acacia’s own standalone DSP ASICs. In that configuration, the combination of CFP2-ACO module and DSP ASIC would infringe the Asserted Patent, for the same reasons discussed herein that Acacia’s integrated CFP2-DCO modules (with an Acacia Meru DSP ASIC built into the module) infringe.

36. Each of Acacia’s currently offered coherent optical transceiver modules employ Silicon Photonics optical modulator ICs developed by Acacia. *See, e.g.*, Coherent Interconnect Module 8, *available at* https://acacia-inc.com/product/coherent-interconnect-module-8/ (“It combines the 5nm CMOS Jannu DSP with our 3D Siliconization packaging technology which includes the silicon photonics integrated circuit (SiPh PIC), high-speed modulator driver and transimpedance amplifier (TIA) in a single opto-electronic package”); OSFP Product Family, *available at* https://acacia-inc.com/product/osfp-product-family/ (“our silicon photonic integrated circuit (PIC)”); QSFP-DD Product Family, *available at* https://acacia-inc.com/product/qsfp-dd-product-family/ (“our silicon photonic integrated circuit (PIC)”); AC1200 Product Family, *available at* https://acacia-inc.com/product/ac1200/ (“Key Acacia technologies include:” “Highly integrated silicon photonics circuit that supports high baud rates while reducing interconnect costs”); CFP2-DCO Product Family, *available at* https://acacia-inc.com/product/cfp2-dco/, (“Acacia’s silicon PIC”); AC400 Flex Product Family, *available at* https://acacia-inc.com/product/ac400-flex/ (“Leveraging our dual-core Denali DSP and in-house

silicon PIC technology"); CFP2-ACO Product Family, *available at* https://acacia-inc.com/product/cfp2/ ("Acacia's CFP2-ACO is our fourth Acacia product family to utilize its integrated coherent silicon PIC"); CFP-DCO Product Family, *available at* https://acacia-inc.com/product/cfp-dco/ ("The integration of power saving DSP technology and silicon photonic integrated circuit (PIC) technologies has allowed Acacia to optimize the balance of power and performance"); *see also* Silicon Photonic Integrated Circuits (PICs), *available at* https://acacia-inc.com/product/silicon-photonic-integrated-circuits-pic/:



37. Acacia's Silicon Photonic Integrated Circuits employ multiple Mach-Zehnder optical modulators. *See, e.g.*, L. Chen, *et al.*, Silicon Photonics for 100G-and-beyond Coherent Transmissions, OFC 2016 at 1 ("The chip includes 4 carrier- depletion Mach-Zehnder modulators"), Figs 1(a)-(d):

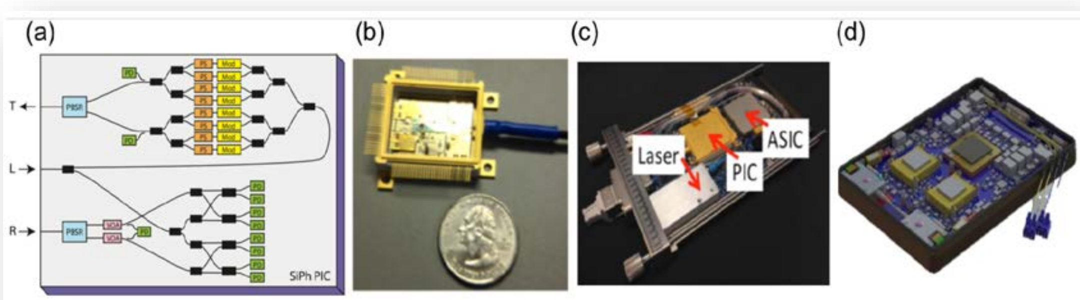
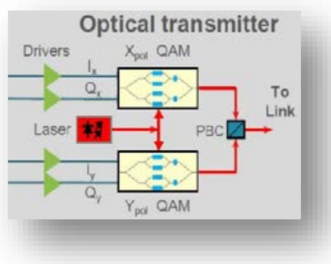


Fig. 1. Silicon coherent PIC and modules. (a) Block diagram of a silicon single chip transceiver excluding laser. (b) Gold box with the silicon PIC packaged with drivers, transimpedance amplifiers, fiber array, and other components. (c) Acacia's coherent CFP with the silicon PIC and ASIC. (d) Acacia's dual-carrier with one ASIC and two silicon PICs.

See also C. Doerr, *et al.*, Single-Chip Silicon Photonics 100-Gb/s Coherent Transceiver, OFC Postdeadline 2014 ("On the transmitter side, there are two in-phase (I) / quadrature (Q) traveling wave Mach-Zehnder modulators (MZMs)"); H. Zhang, *et al.*, Real-time transmission of 16 Tb/s over 1020km using 200Gb/s CFP2-DCO, Optics Express, Vol. 26, No. 16, Mar. 19, 2018 at 2, *available at* https://acacia-inc.com/wp-content/uploads/2018/03/Optics-Express-26-6-6943.pdf ("The CFP2-DCO module . . . integrates a tuneable narrow-linewidth laser, a single-chip silicon photonic integrated circuit for quad-parallel Mach-Zehnder modulators"); Presentation, Coherent Optical Solutions for Data Center Interconnect, Optinet 2019, June 13, 2019 at 6, *available at* https://acacia-inc.com/wp-content/uploads/2019/06/Optinet-China-2019_Acacia_Fenghai-Liu_UpLoad_v1.pdf (image detail below):



38. Acacia's coherent optical transceiver modules (and DSP ASIC components thereof) achieve optical networking transport speeds of 100 Gbps and above by employing the digital signal mapping techniques of the Asserted Patent. Mapping of the digital symbols prior to transmission to pre-equalize or compensate for modulator non-linearity and other such signal degradations is necessary at the high per-lane speeds and extended reaches at which Acacia's products operate. Accordingly, Acacia's various generations of DSP ASIC perform multiple digital mappings according to the claims of the Asserted Patent, in order to implement these digital pre-compensation functions. *See, e.g.*, H. Zhang, *et al.*, "Real-time Transmission of Single-Carrier 400 Gb/s and 600 Gb/s 64QAM over 200km-Span Link," ECOC 2019 at 1

("High-baud rate 64QAM is intrinsically more susceptible to noise as well as linear and nonlinear distortions from analog electrical and optical components. Transmitter pre-distortion effectively improves the performance of high-baud rate 64QAM."), 2 ("digital pre-distortion"); 2 ("The ASIC includes . . . a DSP engine which performs pulse shaping and pre-equalization on the transmitter side"), Fig. 1.:

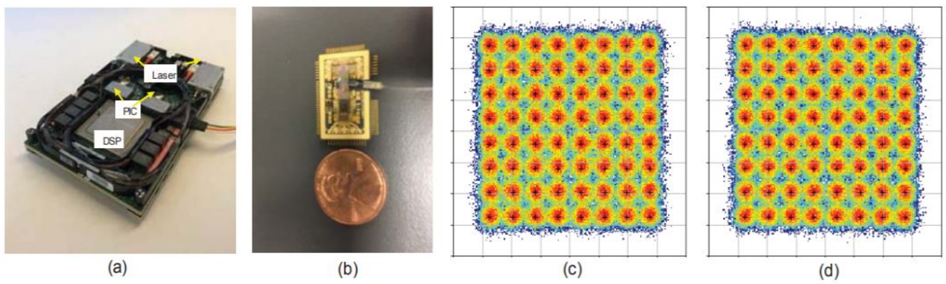
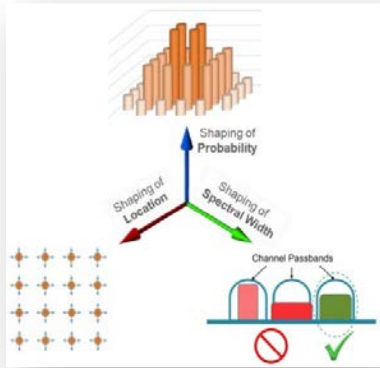


Fig. 1. (a) Coherent transciver and (b) silicon-photonics integrated citucits, (c, d) Received 64 QAM constellation in X- and Y- polarizations at 69 GBd

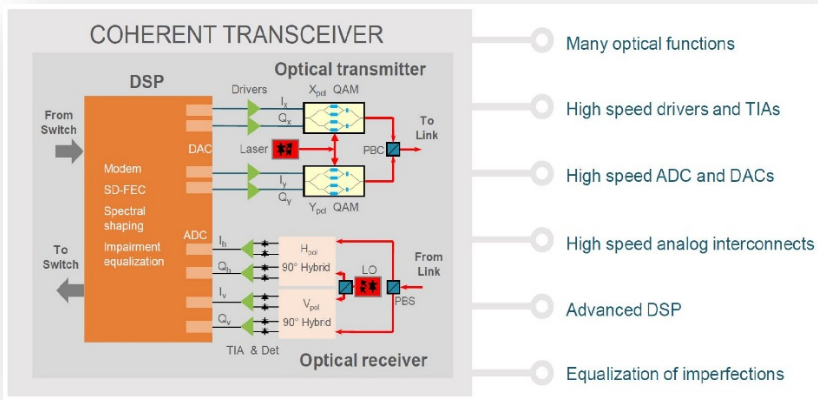
39. For example, Acacia advertises that its AC1200 module and Pico DSP ASIC perform "3D Shaping" on transmit modulation constellation points. *See, e.g.*, AC1200 Product Family, *available at* https://acacia-inc.com/product/ac1200/ ("A primary capability of the AC1200 family is 3D-Shaping which enables fine-tune adjusting of the line-side modulation characteristics helping network operators optimize capacity and reach for their particular network or link"); Blog, Get in Shape with the AC1200, *available at* https://acacia-inc.com/blog/get-in-shape-with-the-ac1200/; Whitepaper, Optimize Network Utilization with 3D Shaping, *available at* https://acacia-inc.com/wp-content/uploads/2018/05/Optimize-Network-Utilization-with-Acacia-3D-Shaping.pdf ("3D Shaping enables fine-tune adjusting of the line-side coherent modulation characteristics"):



These digital shaping adjustments utilize the claimed digital mapping of the Asserted Patent.

40. Acacia's publications and product marketing material emphasize the capability of its DSP ASICs to perform digital pre-equalization or compensation of signals to be transmitted—to correct for non-linearity and other known signal degradations. *See, e.g.*, H. Zhang, *et al.*, "Real-time Transmission of Single-Carrier 400 Gb/s and 600 Gb/s 64QAM over 200km-Span Link," ECOC 2019 at 1 ("susceptible to noise as well as linear and nonlinear distortions from analog electrical and optical components. Transmitter pre-distortion effectively improves the performance"); Whitepaper, "Network Optimization in the 600G Era," *available at* https://acacia-inc.com/acacia-resources/white-paper-network-optimization-in-the-600g-era/ (discussing use of features such as "nonlinear equalization" to "provide additional system margin improvement"); H. Zhang, *et al.*, Real-time transmission of 16 Tb/s over 1020km using 200Gb/s CFP2-DCO, Optics Express, Vol. 26, No. 16, Mar. 19, 2018 at 3, *available at* https://acacia-inc.com/wp-content/uploads/2018/03/Optics-Express-26-6-6943.pdf ("The ASIC includes . . . a DSP engine which performs pulse shaping and pre-equalization on the transmitter side"); Presentation, Coherent Optical Solutions for Data Center Interconnect, Optinet 2019, June 13, 2019, at 6, *available at* https://acacia-inc.com/wp-content/uploads/2019/06/Optinet-China-

2019_Acacia_Fenghai-Liu_UpLoad_v1.pdf (highlighting digital "Impairment equalization" in Acacia's DCP ASIC for "Equalization of imperfections" in the signal path):



41. Acacia has specifically highlighted the benefits it receives from use of the inventions of the Asserted Patent for signal compensation, marketing its use of DSP technology to provide a "better algorithm to mitigate or compensate the penalty from those [photonic and RF] components." *See, e.g.*, Video, Acacia Talks Coherent: Hongbin Zhang and Digital Signal Processing, *available at* https://acacia-inc.com/acacia-resources/acacia-talks-coherent-hongbin-zhang-and-digital-signal-processing/ (last accessed Feb. 4, 2022). A screenshot from this marketing video on Acacia's commercial website highlights "3D Shaping" and "Non-linear compensation" as key benefits of its DSP technology:

See also Whitepaper: 100GBaud+ Silicon Photonics Solutions Drive Optical Network Evolution, *available at* https://acacia-inc.com/wp-content/uploads/2020/12/100GBaud-Silicon-Photonics-Solutions-Drive-Optical-Network-Evolution.pdf (noting need for "techniques to mitigate opto-electronic RF signal impairments"). These features are made possible through Acacia's infringement of the Asserted Patent.

42. As described above, and detailed with respect to patent claims below, Acacia's infringing coherent optical transceiver modules (and DSP ASIC and Silicon Photonic IC components thereof) (the "Acacia Accused Products") support advanced mapping and modulation techniques according to the Asserted Patent—including without limitation digital mapping to provide digital pre-equalization, pre-distortion, shaping, and non-linearity compensation, and modulation by varied quadrature modulation formats (*e.g.*, QPSK, 8QAM, 16QAM, 32QAM, 64QAM, etc.).

43. The Acacia Accused Products include, but are not limited to: 100, 200, and 400 Gbps pluggable CFP-DCO and CFP2-DCO modules; 1.2T (AC1200) and 400G (AC400) embedded modules; CIM8 pluggable modules; 400 Gbps OSFP and QSFP-DD pluggable modules that operate relative to 400ZR or OpenZR+ industry implementation agreements; and 100G QSFP-DD pluggable modules; as well as any similarly capable products under development by Acacia. The Acacia Accused Products also include Acacia's CFP2-ACO modules to the extent they are used with an Acacia DSP ASIC on a linecard. Acacia is also accused of directly infringing via its reference and test designs, and indirectly infringing by inducing or contributing to its customer's designs—that implement one of Acacia's Denali, Meru, Pico, Greylock, or Jannu DSP ASICs coupled together with one of Acacia's Silicon Photonic ICs.

44. Cisco (through its wholly owned subsidiary Acacia) makes, uses, offers to sell, sells (including directly to end users and as an original equipment manufacturer to resellers), and/or imports into the United States the Acacia Accused Products. On information and belief, Cisco (through its wholly owned subsidiary Acacia) also uses the Accused Products during testing in the United States and uses and offers the Accused Products during demonstrations and trials with customers and partners and through the activities of its Sales team and its Field and Systems Applications Engineers. Cisco (through its wholly owned subsidiary Acacia) further uses and offers its Accused Products at industry trade shows and demonstrations to existing or potential customers. *See, e.g.*, Blog: "Introducing the AC1200-SC^2 Coherent 1.2T Single-Chip, Single-Channel Module," *available at* https://acacia-inc.com/blog/introducing-the-ac1200-sc2-coherent-1-2t-single-chip-single-channel-module/; Blog, Aloha PTC '19 – Acacia Prepares to Hang-10 at the annual Pacific Telecommunications Council event, *available at* https://acacia-

inc.com/blog/aloha-ptc-19-acacia-prepares-to-hang-10-at-the-annual-pacific-telecommunications-council-event/.

B. Cisco Optical Transceiver Modules and Line Cards

45. On information and belief, Cisco makes, uses, sells, and/or offers to sell in the United States, and/or imports into the United States various networking equipment including routers and switches. For example, Cisco makes, uses, and sells converged networking routers and switches, for use in high-speed local, metro, and wide-area networks, that include high-speed optical networking ports. In addition, Cisco sells datacenter and cloud switches that include high-speed optical networking ports.

46. Many of these Cisco router and switch products include line cards and associated optical transceiver modules that together enable high-speed optical communications of 100 Gbps or higher per port. *See, e.g.*, Cisco Brochure c02-741700, "The Next Frontier for Cloud Networking: Cisco Nexus 400G" (Jan. 2019), *available at* https://www.cisco.com/c/dam/en/us/solutions/collateral/data-center/high-capacity-400g-data-center-networking/brochure-c02-741700.pdf; Cisco Datasheet c78-729222, "Cisco Network Convergence System 4000 Series" (Nov. 2018), *available at* https://www.cisco.com/c/en/us/products/collateral/optical-networking/network-convergence-system-4000-series/data_sheet_c78-729222.pdf; Cisco Datasheet c78-741560, "Cisco Nexus 9300-GX Series Switches" (July 2021), *available at* https://www.cisco.com/c/en/us/products/collateral/switches/nexus-9000-series-switches/nexus-9300-gx-series-switches-ds.pdf; Cisco Datasheet c78-742571, "Cisco 8000 Series Routers Data Sheet" (Sept. 2021), *available at* https://www.cisco.com/c/en/us/products/collateral/routers/8000-series-routers/datasheet-c78-742571.pdf:

47. Cisco's various routers and switches include line cards, including removable blades and built-in circuit boards, that include functionality to provide digital signal processing for various optical networking ports, including Optical Transport Network (OTN) or Ethernet ports operating at speeds up to and including 100, 200, and 400 Gbps. *See, e.g.*, Cisco Datasheet c78-736495, "Cisco NCS 4000 400 Gbps DWDM/OTN/Packet Universal Line Card" (Sept. 2017), *available at* https://www.cisco.com/c/en/us/products/collateral/optical-networking/network-convergence-system-4000-series/datasheet-c78-736495.pdf ("Up to 2x 200 Gbps Dense Wavelength-Division Multiplexing (DWDM) wavelengths using the CFP2 ports"); *see also* Cisco Datasheet c78-741557, "Cisco Nexus 3432D-S Switch" (Apr. 2019), *available at* https://www.cisco.com/c/en/us/products/collateral/switches/nexus-3000-series-switches/datasheet-c78-741557.pdf ("Each QSFP-DD port can operate at 400, 100, 50, 40, and 25 Gbps"); Cisco Datasheet c78-2463203, "Cisco Network Convergence System 1004 800G QSFP-DD Transponder Line Card" (Sept. 2021), *available at* https://www.cisco.com/c/en/us/products/collateral/optical-networking/network-convergence-system-1000-series/network-convergence-system-1004-800g-ds.pdf; Cisco Datasheet c78-239132, "Cisco NCS 2000 1.2 Tbps DWDM Line Module" (Aug. 2021), *available at*

https://www.cisco.com/c/en/us/products/collateral/optical-networking/network-convergence-system-2000-series/datasheet-c78-2391320.pdf; Cisco Datasheet c78-742016, "Cisco Network Convergence System 5700 Series: 400GE and 100GE Line Cards Data Sheet" (Jan. 2022), *available at* https://www.cisco.com/c/en/us/products/collateral/routers/network-convergence-system-5500-series/datasheet-c78-742016.pdf; Cisco Datasheet c78-742571, "Cisco 8000 Series Routers Data Sheet" ("36-port QSFP56-DD 400 GbE line card"):

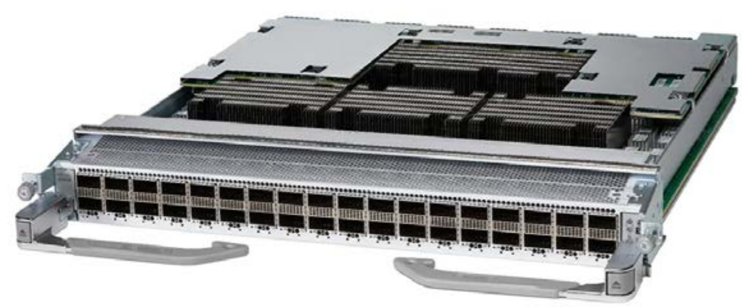


Figure 10.
36-port QSFP56-DD 400 GbE line card

48. Cisco makes, uses, and/or sells various optical transceiver modules for use with the optical networking ports on its routers and switches. *See, e.g.*, Cisco Datasheet c78-736495 at 2 ("CFP2 ACO pluggables"); Cisco Datasheet c78-741557 at 3 ("The Cisco Nexus 3400-S are Quad Small Form factor pluggable – Double Density (QSFP-DD) platforms that support the full range of optical transceviers [sic]"); Cisco Brochure c02-741700 at 2 ("400G optics: QSFP-DD" and "QDD-400G-FR4-S"); Cisco Product Brief c45-740242, "Cisco 40/100Gb QSFP100 BiDi Pluggable Transceiver" (Feb. 2018), *available at* https://www.cisco.com/c/en/us/products/collateral/interfaces-modules/transceiver-modules/at-a-glance-c45-740242.pdf. *See also* Cisco Datasheet c78-744377, "Cisco 400G Digital Coherent Optics QSFP-DD Optical Modules Data Sheet" (Oct. 2021), *available at*

https://www.cisco.com/c/en/us/products/collateral/interfaces-modules/transceiver-modules/datasheet-c78-744377.pdf; Cisco Datasheet c78-743172, "Cisco 400G QSFP-DD Cable and Transceiver Modules Data Sheet" (Jan. 2022), *available at* https://www.cisco.com/c/en/us/products/collateral/interfaces-modules/transceiver-modules/datasheet-c78-743172.pdf; Cisco Datasheet c78-73628, "Cisco 100GBASE QSFP-100G Modules Data Sheet" (Aug. 2021), *available at* https://www.cisco.com/c/en/us/products/collateral/interfaces-modules/transceiver-modules/datasheet-c78-736282.pdf.

49. These optical transceiver modules are sold in a variety of configurations, varying in form factor, communication speed, optics supported, and type of modulator employed. Numerous variations of these transceiver modules operating at speeds of 100Gbps and above, along with associated digital signal processing functionality in the modules and/or on the associated line cards, infringe the Asserted Patent, as further detailed herein.

50. Cisco participates in and leads various industry standards, multi-vendor implementation agreements, and specification efforts to define the physical form factor, operation, requirements, and capabilities of its optical transceiver modules. For example, the CFP2 ACO pluggable modules used, *inter alia*, with the NCS 4000 400 Gbps DWDM/OTN/Packet Universal Line Card, are defined and specified in part in Optical Internetworking Forum, OIF-CFP2-ACO-01.0, Implementation Agreement for Common Analog Coherent Optics Module (Jan. 22, 2016). Cisco's QSFP-DD and other modules are also defined in various industry standards and implementation agreements in which Cisco participates, such as the 100G Lambda MSA Group's 100G-FR, 100G-LR, and 400G-FR4 Technical Specifications, Rev 2.0 (Sept. 18, 2018), and the QSFP-DD MSA's Common Management

Interface Specification, Rev 3.0 and Hardware Specification, Rev 4.0 (Sept. 18, 2018), as well as related IEEE standards and standardization efforts. Cisco promotes these industry standards and implementation agreements, and their resulting specifications, including on its website and blogs.

51. Cisco's infringing products achieve optical networking transport speeds of 100 Gbs and above by employing the advanced modulation techniques and digital mapping of the Asserted Patent, including via signal processing in its line cards and/or optical transceiver modules. *See, e.g.*, Cisco Datasheet c78-736495 at 2 ("The NCS 4000 Universal line card also provides two 200 Gbps 16-QAM DWDM Long Haul transmission ports through the CFP2 ACO pluggables" and "latest generation of Digital Signal Processor (DSP) technology dramatically increases the performance of 100 Gbps QPSK and 200 Gbps 16-QAM optical transport"); Cisco Datasheet c78-741557 at 3 ("The Cisco Nexus® 3400-S is the first 400G programmable switch series in the Nexus 3000 portfolio with 50 Gbps PAM4 Serial-Deserializers (SerDes), and is designed for data centers with industry-leading performance-per-watt power efficiency at low latency"); Cisco Product Brief c45-740242 at 1 ("PAM4 optical modulation"); Cisco Datasheet c78-728110, "Cisco CPAK 100GBASE Modules Data Sheet" (Aug. 2021), *available at* https://www.cisco.com/c/en/us/products/collateral/interfaces-modules/transceiver-modules/data_sheet_c78-728110.pdf ("The Cisco CPAK-100G-FR Module supports link lengths of up to 2 km over a standard pair of G.652 Single-Mode Fiber (SMF) with duplex LC connectors. The 100 Gigabit Ethernet optical signal is carried over a single wavelength using a PAM4 (Pulse-Amplitude Modulation 4-Level) modulation scheme.").

52. Cisco has publicly acknowledged and endorsed the need for, and adoption of, the advanced modulation techniques of the Asserted Patent in order to achieve data rates of 100 Gbps and higher using fewer lines or channels. *See, e.g.*, Cisco Blog SP360: Service Provider,

"PAM4 for 400G Optical Interfaces and Beyond (Part 1)," *available at* https://blogs.cisco.com/sp/pam4-for-400g-optical-interfaces-and-beyond-part-1 ("In order to avoid costly electrical and optical design, there has been a recent revival of research on coherent technology and multi-level modulation formats to achieve greater than 25G channel rates. 4-level pulse amplitude modulation (PAM4), a relatively low-cost solution, has been adopted in the transceiver industry, enabling high-speed data rates, toward 400G and beyond."); Solution Overview: "Single-Lambda 100G Pluggable Optics Solution Overview" (June 2021), *available at* https://www.cisco.com/c/en/us/products/collateral/interfaces-modules/transceiver-modules/solution-overview-c22-743387.pdf. Cisco's optical transceivers homepage touts infringing technologies that it developed, and also acquired from Acacia, such as Silicon Photonics, Pluggable Coherent Optics, and 100G PAM4 "single lambda" transceivers. *See* "Cisco Optics," at https://www.cisco.com/c/en/us/products/interfaces-modules/transceiver-modules/index.html (last visited February 6, 2022).

53. The advanced digital mapping techniques of the Asserted Patent are key features of products crucial to Cisco's optical networking platforms. For example, Cisco advertises the Pluggable Coherent Optics it acquired from Acacia—which on information and belief use the digital mapping techniques of the Asserted Patent—as an enabling technology for Cisco's "Routed Optical Networking" initiative. "Pluggable Coherent Optics for Routed Optical Networking At-a-Glance" (Feb. 2021), *available at* https://www.cisco.com/c/en/us/products/collateral/interfaces-modules/transceiver-modules/at-a-glance-c45-744704.pdf ("TX filter shaping").

54. Cisco's "Routed Optical Networking" homepage describes how: "Routers are connected hop-by-hop with standardized pluggable coherent optics." *See, e.g.*, Cisco Routed

Optical Networking, https://www.cisco.com/c/en/us/solutions/service-provider/routed-optical-networking/index.html (last visited Feb. 6, 2022); Blog: "Routed Optical Networking – It's About the Architecture" (Nov. 9, 2021), *available at* https://blogs.cisco.com/sp/routed-optical-networking-its-about-the-architecture ("Pluggable Coherent Optics: With advances in silicon and silicon photonics, we are now able to deliver 400G coherent wavelengths in a pluggable that may be plugged directly into the router. . . . It is our conviction around the value of pluggable coherent optics to our customers that led Cisco to acquire Acacia in March 2021."); Blog: "650,000+ Coherent Ports Shipped by Cisco and Acacia" (June 3, 2021), *available at* https://blogs.cisco.com/sp/650000-coherent-ports-shipped-by-cisco-and-acacia; Cisco Annual Report – 2021 at 3, *available at* https://www.cisco.com/c/dam/en_us/about/annual-report/cisco-annual-report-2021.pdf ("We launched a new routed optical networking solution integrating our scalable, high-performance routers and Acacia's pluggable optics, which offers significant cost savings. We are also significantly expanding our footprint with our webscale customers as they begin their 400G upgrade cycles.").

55. As described above, the coherent pluggable optics that Cisco paid $4.5 billion to acquire from Acacia use the digital mapping techniques of the Asserted Patent to provide digital pre-equalization, pre-distortion, shaping, and non-linearity compensation. *See also* Cisco Datasheet c78-744377, "Cisco 400G Digital Coherent Optics QSFP-DD Optical Modules Data Sheet" (Oct. 2021), *available at* https://www.cisco.com/c/en/us/products/collateral/interfaces-modules/transceiver-modules/datasheet-c78-744377.pdf ("multiple configuration options in terms of Modulation scheme, TX filter shaping" and "signal shaping"); Cisco Datasheet c78-743732, "Cisco Digital CFP2-DCO Coherent Optical Module Data Sheet" (June 2021), *available*

at https://www.cisco.com/c/en/us/products/collateral/interfaces-modules/transceiver-modules/datasheet-c78-743732.pdf.

56. Cisco's infringing products also achieve optical networking transport speeds of 100 Gbs and above by employing the digital signal mapping techniques of the Asserted Patent. Mapping of the digital symbols to correct for modulator non-linearity and other such signal degradations is necessary at the high per-lane speeds at which the infringing products operate. Industry standards, including for example the IEEE 802.3bs-2017 standard amendment, have included, *inter alia*, transmitter linearity and signal quality requirements and tests in recognition of this need. *See* IEEE Standard for Ethernet, "Amendment 10: Media Access Control Parameters, Physical Layers, and Management Parameters for 200 Gb/s and 400 Gb/s Operation," IEEE Std 802.3bs-2017 at §§ 120D.3.1.1 - 120D.3.1.8. Cisco's infringing products comply with these and similar transmission signal quality requirements, including through the use of the digital signal mapping techniques of the Asserted Patent.

57. Cisco's infringing transceiver modules and associated DSP functionality (the "Cisco Accused Products")[2] support advanced mapping and modulation techniques, including without limitation Quadrature Modulation (*e.g.*, 16-QAM) and Pulse Amplitude Modulation (*e.g.*, PAM4). The Accused Products include, but are not limited to: 100, 200, and 400 Gbps pluggable coherent modules, including CFP2-ACO and CFP2-DCO modules, and QSFP-DD or OSFP format 400G ZR modules; 100 Gbps and higher-speed embedded coherent modules; 100, 200, and 400 Gbps QSFP28, QSFP56 and QSFP-DD pluggable modules, including modules that operate at speeds at or above 50 Gbps per optical or electrical lane; "BiDi" modules that

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[2] The Acacia Accused Products described above are also Cisco Accused Products now that Acacia has been acquired by and is wholly owned by Cisco. They are listed as separate categories of Accused Product here simply for convenience of reference.

communicate at or above 100 Gbps, including 100G BiDi or 400G BiDi products; 100G "single lambda" modules that communicate according to the 100G-FR, 100G-LR, 400G-FR4, or similar Technical Specifications; and other modules that include similar functionality, along with the associated digital signal processing functionality, whether implemented in the module itself or in an associated circuit or processor.

58. Examples of Cisco Accused Products currently offered for sale on Cisco's website include, but are not limited to: CFP2-ACO pluggable transceivers (*e.g.*, ONS-CFP2-WDM); CFP2-DCO pluggable transceivers (*e.g.*, CFP2-WDM-DETS-1HL, CFP2-WDM-DS-1HL, CFP2-LIC-UPG-200G); 400G ZR coherent pluggable transceivers (*e.g.*, QDD-400G-ZR-S, QDD-400G-ZRP-S); Single-lambda CPAK transceivers, *e.g.*, CPAK-100G-FR; 40/100G "BiDi" transceivers, *e.g.*, QSFP-40/100G-SRBD; 100G single-lambda QSFP transceivers (*e.g.*, QSFP-100G-DR-S, QSFP-100G-FR-S, QSFP-100G-LR-S, QSFP-100G-ELR-S); and 400G pluggable QDFP56 or QSFP-DD transceiver modules (*e.g.*, QDD-400G-DR4-S, QDD-400G-FR4-S, QDD-400G-LR4-S, QDD-400G-LR8-S, QDD-4x100G-FR-S, QDD-4x100G-LR-S, QDD-400-AOCxM).

59. In addition, Cisco Accused Products include Cisco's numerous line cards and systems with embedded coherent transceivers, such as the Cisco NCS 2000 200-Gbps Multirate DWDM Line Card (*e.g.*, NCS2K-200G-CK-C=), the NCS1004 system, C-Band 1.2T Transponder Line Card, L-Band Transponder Line Card, and 800G QSFP-DD Transponder Line Card (*e.g.*, NCS1K4-1.2T-K9=, NCS1K4-1.2TL-K9=, NCS1K4-2-QDD-C-K9=). *See*, *e.g.*, Cisco Datasheet c78-733699, "Cisco NCS 2000 200-Gbps Multirate DWDM Line Card Data Sheet" (July 2015), *available at* https://www.cisco.com/c/en/us/products/collateral/optical-networking/network-convergence-system-2000-series/datasheet-c78-733699.pdf; Cisco

Datasheet c78-744554, "Cisco Network Convergence System 1004 C-Band 1.2T Transponder Line Card Data Sheet" (July 2021), *available at* https://www.cisco.com/c/en/us/products/collateral/optical-networking/network-convergence-system-1000-series/datasheet-c78-744554.pdf:

Figure 1.
Cisco NCS 1004 1.2T C band line card

60. In addition, Cisco Accused Products include Cisco's numerous line cards and systems with embedded DSP circuitry and slots for pluggable optics such as CFP2-ACO transceivers, such as the NCS 1002 system (*e.g.*, NCS 1002-K9=); Cisco NCS 2000 series, 400 Gbps XPonder Card (*e.g.*, NCS2K-400G-XP=), the NCS 4000 series, 400 Gbps DWDM/OTN/Packet Universal Line Card (*e.g.*, NCS4K-4H-OPW-QC2=), the Cisco NCS 5500 series, 1.2-Tbps IPoDWDM Modular Line Card (*e.g.*, NC55-6x200-DWDM-S), or the Cisco 9000 Series Routers, 400G and 200G Modular Line Cards (*e.g.*, A9K-MOD400-SE line card with A9K-MPA-2X100GE modular port adaptor). *See*, *e.g.*, Cisco Datasheet c78-736916, "Cisco NCS 2000 400 Gbps XPonder Line Card Data Sheet" (Jan. 2021), *available at* https://www.cisco.com/c/en/us/products/collateral/optical-networking/network-convergence-system-2000-series/datasheet-c78-736916.pdf:

Figure 1.
Cisco NCS 2000 400 Gbps XPonder

61. Cisco makes, uses, offers to sell, sells (including by technology leases to its customers), and/or imports into the United States the Accused Products. On information and belief, Cisco also uses the Accused Products during testing in the United States and uses and offers the Accused Products during demonstrations and trials with customers and partners and through the activities of its Sales team and its Field and Systems Applications Engineers. Cisco further uses and offers its Accused Products at industry trade shows and demonstrations to existing or potential customers. *See, e.g.*, Cisco Blog, SP360: Service Provider, "OFC 2017 Demo: Cisco 400GbE Optical Module," *available at* https://blogs.cisco.com/sp/ofc-2017-demo-cisco-400gbe-optical-module; Cisco Blog, SP360: Service Provider, "Cisco Optics On Display and Demonstrated at OFC 2018," *available at* https://blogs.cisco.com/sp/cisco-optics-on-display-and-demonstrated-at-ofc-2018 ("live demo of the QSFP-DD form factor for 400G optical interfaces" and "dual-rate 40/100 Gb QSFP BiDi transceiver"); Cisco Blog, SP360: Service Provider, "Cisco Optics Demos and Displays at OFC 2019," *available at* https://blogs.cisco.com/sp/cisco-optics-demos-and-displays-at-ofc-2019 ("100G 1-λ Silicon

Photonics For 10km. Cisco's silicon photonics will be on display in a live demo, showing single-lambda PAM4 performance over 10km of duplex SMF.").

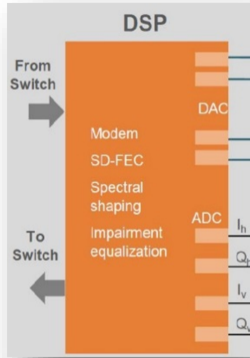
COUNT I
(INFRINGEMENT OF U.S. PATENT NO. 11,342,998)

62. Ramot repeats and incorporates by reference the allegations contained in the preceding paragraphs as if fully set forth herein.

63. Cisco (through its wholly owned subsidiary Acacia) makes, uses, sells, and/or offers to sell in the United States, and/or imports into the United States products that directly infringe the Asserted Patent, including the above identified Cisco Accused Products and Acacia Accused Products that use advanced PAM modulation (*i.e.*, PAM4) or QAM modulation techniques (QPSK, 8-QAM, 16-QAM, 64QAM, etc.), as well as digital mapping of data for, *inter alia*, equalization, pre-distortion, shaping, or compensation of the transmitted signal ("Accused Products"). Cisco's Accused Products that use advanced modulation techniques and digital mapping infringe one or more claims of the Asserted Patent, including without limitation, claim 1 of the Asserted Patent.

64. The Accused Products comprise an optical modulation system. For example, and without limitation, see the evidence cited and discussed above, including with respect to paragraphs 26, 29, 36-37, 48, 51, and 57.

65. The Accused Products comprise an input for a plurality of N digital input data bits. Acacia's coherent optical transceiver modules manipulate digital data in the form of multi-bit words or symbols, which is converted, modulated, and transmitted as optical signals. For example, and without limitation, on information and belief Acacia's DSP ASICs take in, and operate internally, on parallel digital data words. *See, e.g.*, Presentation, Coherent Optical Solutions for Data Center Interconnect, Optinet 2019, June 13, 2019, at 6:



see also Whitepaper, "Network Optimization in the 600G Era," at Figure 7:

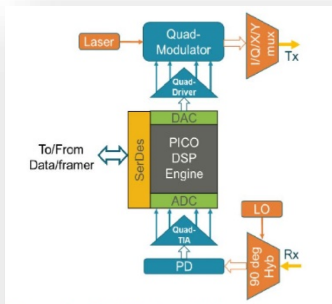


Figure 7. AC1200 simple block diagram. Shared local oscillator (LO) and Tx laser.

Acacia's various transceiver modules and DSP ASICs accept parallel digital data from a host interface and then operate internally on multi-bit symbols. *See, e.g.*, OIF-400ZR-01.0 at 5 ("1x400GAUI-8"):

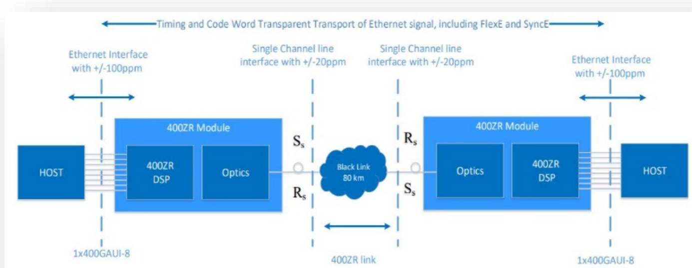


Figure 1: 400ZR reference diagram

See also id. at 18, 48 ("Each 128-bit code word is mapped to 16 DP-16QAM symbols (S)"), Fig. 6.

66. As an additional example, Cisco's optical routers and switches include line cards and modules that manipulate digital data in the form of multi-bit words or symbols, which is converted and transmitted as optical signals. For example, and without limitation, Cisco's Network Convergence System (NCS) 4000 Series products route and switch packet-based digital data and provide optical transmission for transport across networks. *See, e.g.*, Cisco Datasheet c78-729222 at Figure 1:

Figure 1. Cisco NCS 4016 Chassis (Right) and NCS 4009 Chassis (Left)

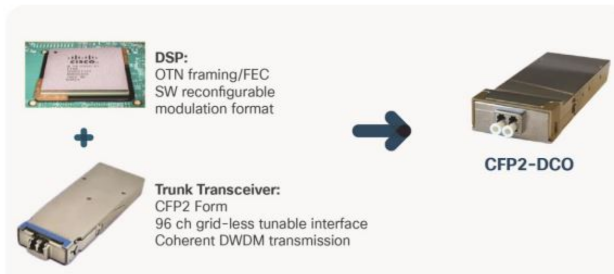
.

See also Cisco Datasheet c78-736495 at Figure 1:

Figure 1. Cisco® NCS 4000 400 Gbps WDM/OTN/Packet Universal Line Card

Id. at 2 ("The NCS 4000 Universal line card also provides two 200 Gbps 16-QAM DWDM Long Haul transmission ports through the CFP2 ACO pluggables."); Cisco Datasheet c78-741079, "Cisco Digital CFP2 Pluggable Optical Module" (July 2018) at Figure 1:.

Figure 1. Difference between analog and digital CFP2 modules



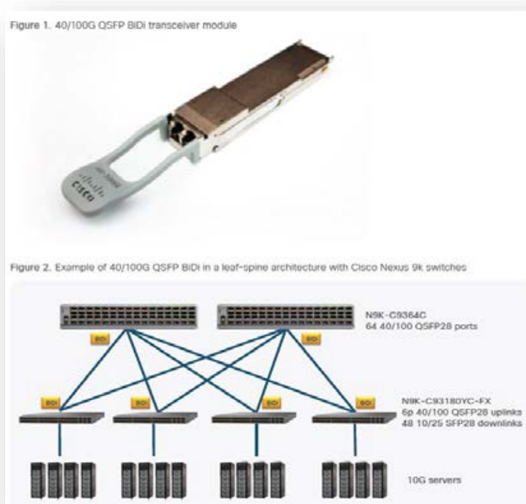
67. As an additional example, Cisco's Nexus 400G products switch digital data and provide optical transmission for transport across networks, including within advanced data centers. *See, e.g.*, Cisco Brochure c02-741700; Cisco Datasheet c78-741557 at 3, Figure 1:

Figure 1.
Cisco Nexus 3432D-S Switch

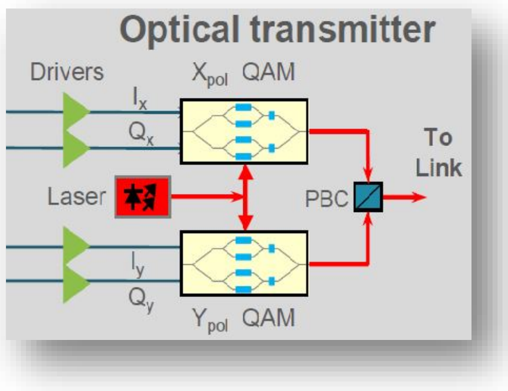
.

Cisco Blog, "OFC 2017 Demo: Cisco 400GbE Optical Module":

See also Cisco Product Brief c45-740242 at 2 ("In 100Gb mode, it operates 50Gb PAM4 channels, for a total aggregate bandwidth of 100Gb. PAM4 technology enables 50Gb data rate with signaling at 25Gbaud rates. The 40/100G BiDi contains a gearbox to translate the signal from a 4x25G format, native to the QSFP28 form factor, to the 2x50Gb format for the optical domain. It also employs onboard forward-error-correction (FEC) to reduce bit error rate."), Figures 1 and 2:



68. The Accused Products comprise an input optical signal. As described above, the Silicon Photonic optical modulators of Acacia's Accused Products have a plurality of waveguide branches, where each branch has an input of an unmodulated optical signal. For example, and without limitation, Acacia's Silicon Photonic ICs take as an input an unmodulated laser which is used in the IC for driving the various arms (*i.e.*, waveguide branches) of a nested Mach-Zehnder type modulator. *See, e.g.*, Presentation, Coherent Optical Solutions for Data Center Interconnect, Optinet 2019, June 13, 2019, at 6:



See also L. Chen, *et al.*, Silicon Photonics for 100G-and-beyond Coherent Transmissions, OFC 2016 at 1 ("Figure 1(a) is a block diagram of the silicon PIC. The three optical IOs ('T', 'L', and 'R') are for transmitter output, laser input that is split between the transmitter and receiver, and receiver input, respectively. The chip includes 4 carrier- depletion Mach-Zehnder modulators"), Figs 1(a)-(d):

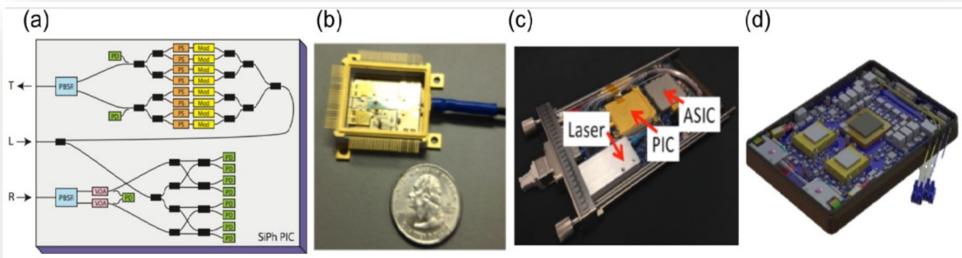


Fig. 1. Silicon coherent PIC and modules. (a) Block diagram of a silicon single chip transceiver excluding laser. (b) Gold box with the silicon PIC packaged with drivers, transimpedance amplifiers, fiber array, and other components. (c) Acacia's coherent CFP with the silicon PIC and ASIC. (d) Acacia's dual-carrier with one ASIC and two silicon PICs.

69. As an additional example, and without limitation, the OIF-CFP2-ACO-01.0 Implementation Agreement for CFP2 modules specifies an unmodulated laser driving the various arms (*i.e.*, waveguide branches) of a nested Mach-Zehnder type modulator. *See, e.g.*, OIF-CFP2-ACO-01.0 at Figure 3:

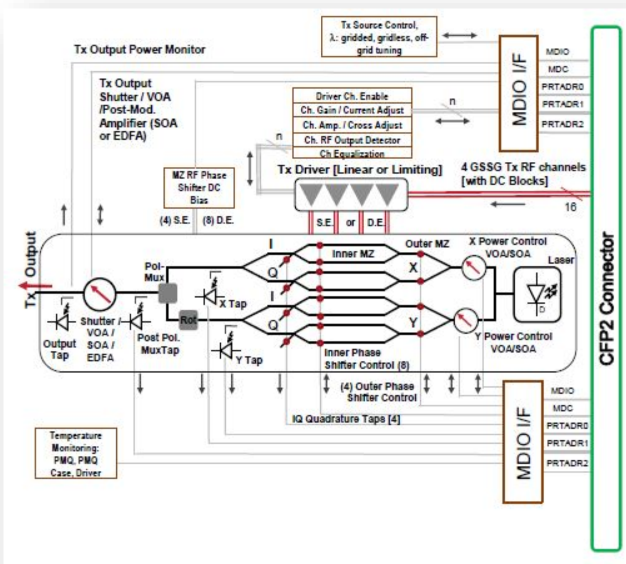


Figure 3: Superset Transmit Function Block Diagram with an MDIO Only Control Interface

A Cisco technical journal paper describes the "[t]ypical components in a CFP2-ACO module" accordingly. *See, e.g.*, Fludger, *et al.*, "1Tb/s Real-Time 4 x 40 Gbaud DP-16QAM Super-

Channel Using CFP2-ACO Pluggable Modules Over 625 km of Standard Fiber," IEEE J. Lighwave Tech. 35, pp. 949, Figure 1 (Feb. 2017):

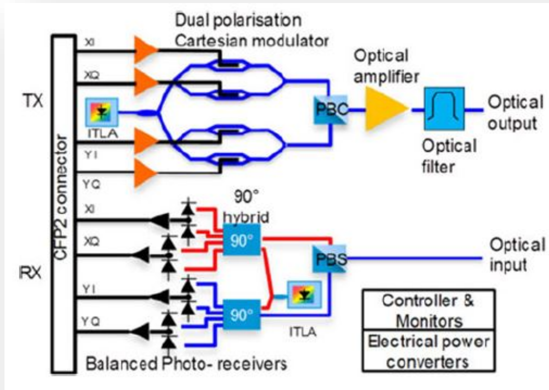
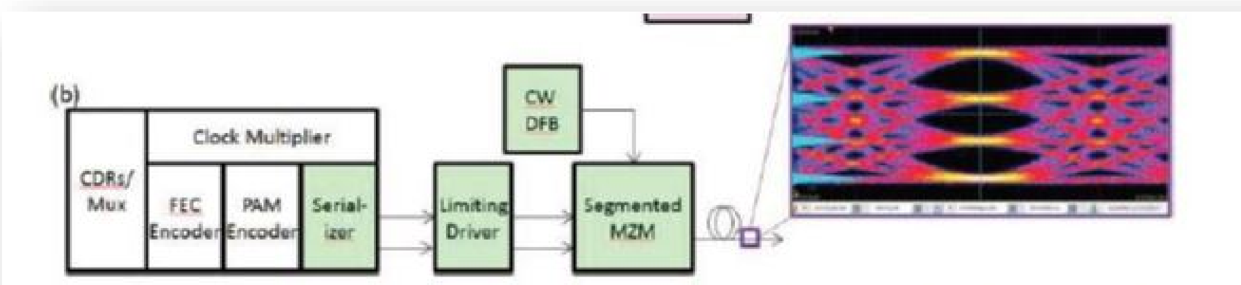


Fig. 1. Typical components in a CFP2-ACO module.

Similarly, another Cisco technical journal paper describes Cisco's use of "Segmented MZM [Mach-Zehnder]" type modulators in QSFP form factor devices to achieve PAM-4 modulation. *See, e.g.*, Mazzini, *et al.*, "25GBaud PAM-4 Error Free Transmission over both Single Mode Fiber and Multimode Fiber in a QSFP form factor based on Silicon Photonics," 2015 Optical Fiber Conference, paper Th5B.3 at 1, Figure 1(b) ("(b) Segmented MZI PAM-4 transmitter block diagram with Cisco PAM-4 optical eye diagrams."):



A continuous-wave (CW) distributed feedback laser (DFB) provides the unmodulated optical signal to the MZM in this example. *Id.*

70. The Accused Products comprise a modulator for modulating the input optical signal responsively to the plurality of N digital input data bits to output a modulation of the input optical signal, thereby generating one or more modulated optical signal outputs for transmission over one or more optical fibers. *See, e.g.*, *id.* at 48 ("DP-16QAM symbols"); H. Zhang, *et al.*, Real-time transmission of 16 Tb/s over 1020km using 200Gb/s CFP2-DCO, Optics Express, Vol. 26, No. 16, Mar. 19, 2018 at Fig. 2:

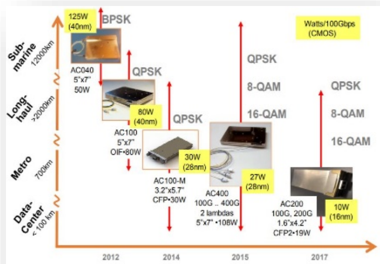


Fig. 2. Evolution in power and density per 100Gbps for coherent transceiver modules.

H. Zhang, *et al.*, "Real-time Transmission of Single-Carrier 400 Gb/s and 600 Gb/s 64QAM over 200km-Span Link," ECOC 2019 at Fig. 1(c) and (d):

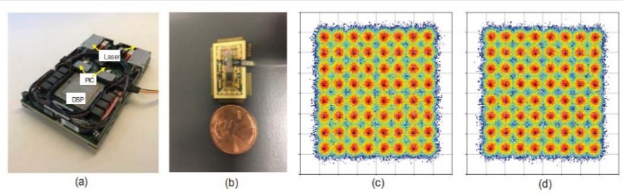
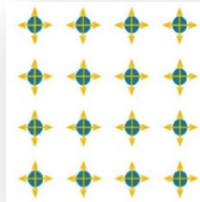


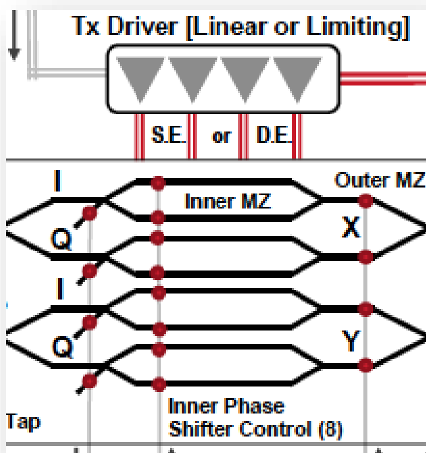
Fig. 1. (a) Coherent transciver and (b) silicon-photonics integrated citucits, (c, d) Received 64 QAM constellation in X- and Y- polarizations at 69 GBd

See also Blog, Get in Shape with the AC1200, at 2 ("Shaping of the constellation points' location to increase reach"):



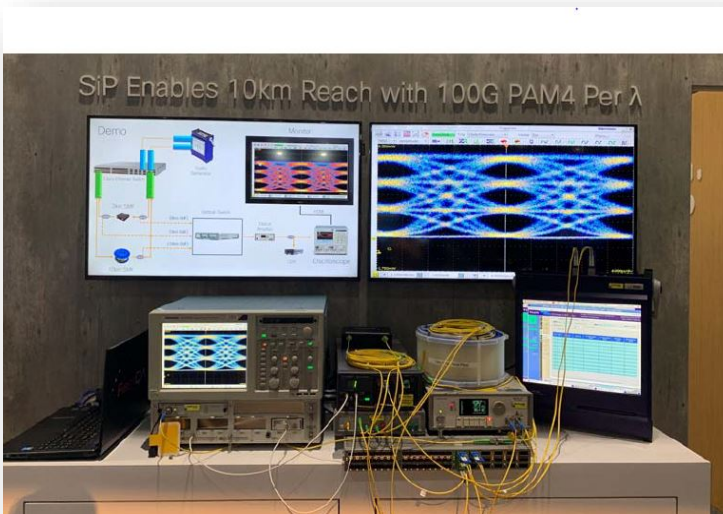
Products Overview ("Our optical interconnect solutions include sophisticated modules engineered to perform a majority of the DSP and optical functions required to process network traffic at transmission speeds of 100 Gbps to greater than 1 Tbps").

71. As an additional example, and without limitation, in Cisco's CFP2 pluggable modules include Mach-Zehnder modulator structures. *See, e.g.*, OIF-CFP2-ACO-01.0 at Figure 3 (detail below):



72. As an additional example, Cisco has made, demonstrated, sold, and offered to sell at least 40G/100G "BiDi," 100G "single lambda," and 400Gbps QSFP-DD pluggable modules including modulators that use PAM4 pulse modulation. Cisco Product Brief c45-740242 at 1 ("PAM4 optical modulation"); Cisco Blog, SP360: Service Provider, "Cisco Optics Demos and

Displays at OFC 2019," *available at* https://blogs.cisco.com/sp/cisco-optics-demos-and-displays-at-ofc-2019 ("100G 1-λ Silicon Photonics For 10km. Cisco's silicon photonics will be on display in a live demo, showing single-lambda PAM4 performance over 10km of duplex SMF."); Cisco Blog, SP360: Service Provider, "Silicon Photonics Demonstration at OFC 2019," *available at* https://blogs.cisco.com/sp/silicon-photonics-demonstration-at-ofc-2019 ("We plugged two of our 100G single-wavelength PAM4 modules into a Cisco Nexus 9k ethernet switch. . . . The PAM4 modules (green in the diagram) had two different spools of single-mode fiber inserted, one for each direction of traffic."):



Cisco Datasheet c78-741560, "Cisco Nexus 9300-GX Series Switches" (July 2021), *available at* https://www.cisco.com/c/en/us/products/collateral/switches/nexus-9000-series-switches/datasheet-c78-741560.pdf, at 3 ("16 x 400/100-Gbps QSFP-DD ports"); "Leviton Cabling Guide for Cisco 100G and 400G Optics" (October 2019) at 1, *available at* https://www.cisco.com/c/dam/en/us/products/collateral/interfaces-modules/transceiver-modules/cabling-guide-100-400g.pdf (listing 100G and 400G part numbers).

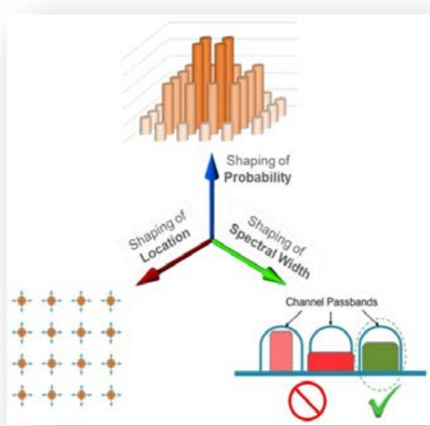
73. The Accused Products generate modulated optical signals for transmission over optical fibers. As described above, Acacia's coherent optical transceiver modules (and Silicon Photonic IC components thereof) each generate and transmit optical signals. *See, e.g.*, Products Overview ("Our optical interconnect solutions include sophisticated modules engineered to perform a majority of the DSP and optical functions required to process network traffic at transmission speeds of 100 Gbps to greater than 1 Tbps"). Acacia's Accused Products have optical fiber ports for transmitting over optical fibers of various lengths, types, and wavelengths. *See, e.g.*, Blog: "Introducing the AC1200-SC^2 Coherent 1.2T Single-Chip, Single-Channel Module ("1.2 Terabit (1.2T) on a single-channel."):

See also H. Zhang, *et al.*, "Real-time Transmission of Single-Carrier 400 Gb/s and 600 Gb/s 64QAM over 200km-Span Link," ECOC 2019 at 1 ("We transmit 41 x 600Gb/s polarization multiplexed (PM) 64QAM channels on a 100 GHz grid over 32 nm bandwidth with uniform loading"); H. Zhang, *et al.*, Real-time transmission of 16 Tb/s over 1020km using 200Gb/s CFP2-DCO, Optics Express, Vol. 26, No. 16, Mar. 19, 2018 at 2 ("We demonstrate transmission of 80 x 200Gb/s polarization multiplexed (PM) 8QAM and 16QAM channels on a 50 GHz grid with 2.8dB and 1.2dB Q^2-factor margin, respectively.").

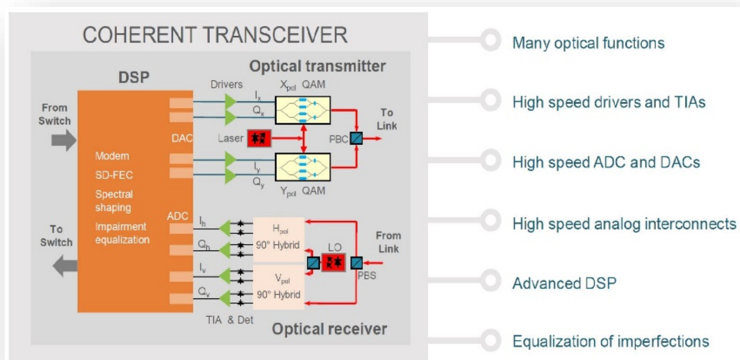
74. As an additional example, and without limitation, Cisco's Accused Products have optical fiber ports for transmitting over optical fibers of various lengths, types, and wavelengths.

See, e.g., Cisco Datasheet c78-741079 at 2 ("16-QAM schemes could offer up to 400km of reach on standard G.652 Single mode fiber"); Cisco Brochure c02-741700 at 2 ("2km duplex SMF (LC)"); Cisco Datasheet c78-736282, "Cisco 100GBASE QSFP-100G Modules" (Aug. 2021), *available at* https://www.cisco.com/c/en/us/products/collateral/interfaces-modules/transceiver-modules/datasheet-c78-736282.pdf, at 2 ("The Cisco QSFP 40/100 Gb dual-rate bi-directional (BiDi) transceiver is a pluggable optical transceiver with a duplex LC connector interface for short-reach data communication and interconnect applications using Multi-Mode Fiber (MMF).").

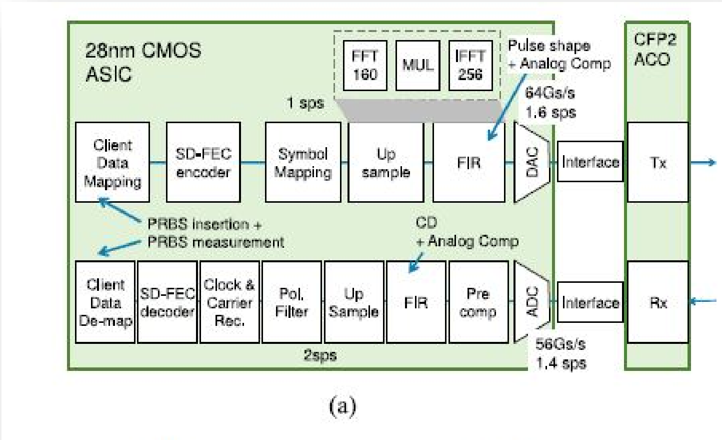
75. The Accused Products comprise the above-described system, wherein a digital-to-digital mapping maps the plurality of N digital input data bits to a set of M digital output data bits associated with a plurality of voltage values. As described above, Acacia's coherent optical transceiver modules (and DSP ASIC components thereof) perform digital signal processing on multi-bit symbols, in order to pre-equalize, pre-distort, shape, or compensate in the digital domain for known impairments. For example, and without limitation, Acacia's DSP ASICs perform "3D Shaping" that "enables fine-tune adjusting of the line-side coherent modulation characteristics." *See, e.g.*, Whitepaper, Optimize Network Utilization with 3D Shaping:



See also Video, Acacia Talks Coherent: Hongbin Zhang and Digital Signal Processing ("mitigate or compensate the penalty from those components" and "Non-linear compensation"); Presentation, Coherent Optical Solutions for Data Center Interconnect, Optinet 2019, June 13, 2019, at 8 ("Efficient EQ for non-perfect optics"), 6 ("Spectral shaping" and "Impairment equalization" in "Advanced DSP" for "Equalization of imperfections"):



76. As an additional example, and without limitation, Cisco's CFP2 pluggable modules (including signal processing components on the line card in the case of CFP2-ACO modules or integrated into the module in the case of CFP2-DCO modules), receive multiple-bit inputs of digital data, then process those digital symbols via mapping, encoding, QAM symbol mapping, and signal conditioning modules that convert the digital data. *See, e.g.*, Fludger *et al.* at Figure 2(a):

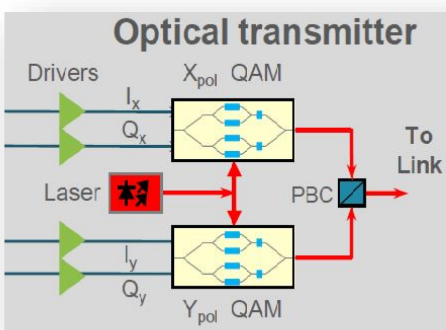


(a)

Fig. 2. (a) ASIC processing, interface and CFP2-ACO pluggable. (b)

See also Mazzini, *et al.*, at Figure 1(b) (describing FEC and PAM4 encoding modules used with a segmented Mach-Zehnder modulator in a QSFP form factor solution).

77. The Accused Products comprise the modulator described above, wherein the input optical signal is modulated based on the plurality of voltage values. For example, and without limitation, in Acacia's coherent optical transceiver modules the QAM modulated symbols and corresponding voltage values described above are coupled to the unmodulated optical signal via Drivers and associated circuitry for the branches of the Mach-Zehnder modulator structures. *See, e.g.*, Presentation, Coherent Optical Solutions for Data Center Interconnect, Optinet 2019, June 13, 2019, at 6 (detail below):



See also C. Doerr, *et al.*, Single-Chip Silicon Photonics 100-Gb/s Coherent Transceiver, OFC Postdeadline 2014 ("adjust the MZM phases to produce QPSK"), Fig. 1:

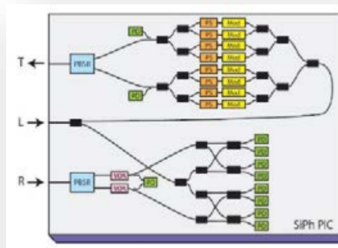
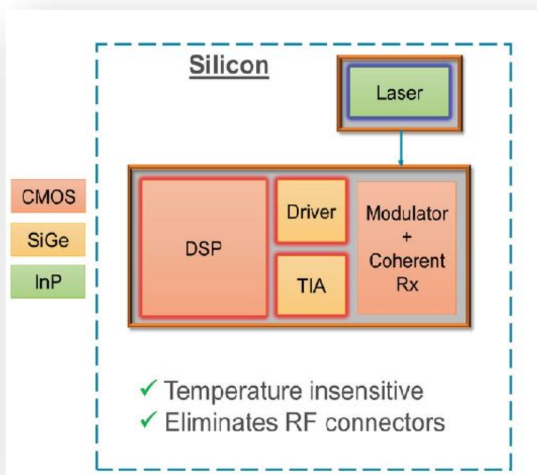


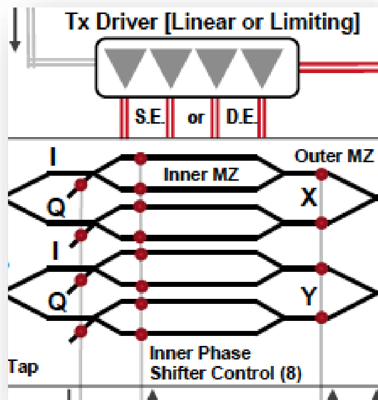
Fig. 1. Block diagram of the SiPh coherent PIC. PS =

See also Whitepaper: 100GBaud+ Silicon Photonics Solutions Drive Optical Network Evolution, available at https://acacia-inc.com/wp-content/uploads/2020/12/100GBaud-Silicon-Photonics-Solutions-Drive-Optical-Network-Evolution.pdf, at 4 ("the DSP and the PIC are tightly co-packaged" with the "high-speed Si modulator driver"), 5 ("high-speed, high-resolution digital-to-analog convertors (DACs)"), Figure 6:



See also Coherent Interconnect Module 8 ("including the DSP, PIC, drivers, and TIAs").

78. As an additional example, in Cisco's CFP2-ACO pluggable modules the digital output data bits described above are provided to digital to analog converters and/or drivers and associated circuitry for the branches of the Mach-Zehnder modulator structures. *See, e.g.*, OIF-CFP2-ACO-01.0 at Figure 3 (detail below):

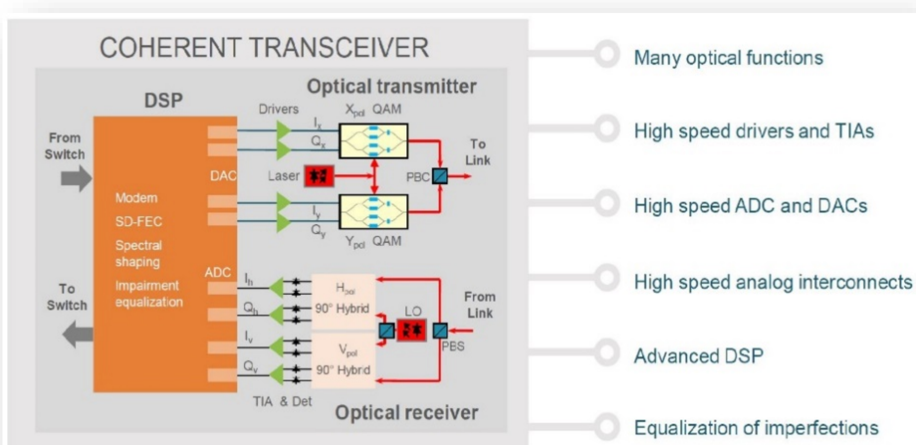


See also Mazzini, *et al.*, at Figure 1(b).

79. The Accused Products comprise the above-described system, wherein the digital-to-digital mapping comprises, for each digital input value included in a set of possible digital input values for the plurality of N digital input data bits, a set of corresponding digital output values from a set of possible digital output values. For example, and as described above, the digital signal processing of the Accused Products described herein maps each digital input value to one of a set of possible corresponding digital output values.

80. For example, the Accused Products include digital-to-digital mapping that outputs a pattern that alters the linearity of an optical response of the modulator. For example, as described above, Acacia's Accused Products use digital signal processing to perform digital pre-equalization, pre-distortion, shaping, and non-linearity compensation. *See, e.g.*, H. Zhang, *et al.*, "Real-time Transmission of Single-Carrier 400 Gb/s and 600 Gb/s 64QAM over 200km-Span

Link," ECOC 2019 at 1 ("susceptible to noise as well as linear and nonlinear distortions from analog electrical and optical components. Transmitter pre-distortion effectively improves the performance"); Whitepaper, "Network Optimization in the 600G Era," *available at* https://acacia-inc.com/acacia-resources/white-paper-network-optimization-in-the-600g-era/ (discussing use of features such as "nonlinear equalization" to "provide additional system margin improvement"); H. Zhang, *et al.*, Real-time transmission of 16 Tb/s over 1020km using 200Gb/s CFP2-DCO, Optics Express, Vol. 26, No. 16, Mar. 19, 2018 at 3, *available at* https://acacia-inc.com/wp-content/uploads/2018/03/Optics-Express-26-6-6943.pdf ("The ASIC includes . . . a DSP engine which performs pulse shaping and pre-equalization on the transmitter side"); Presentation, Coherent Optical Solutions for Data Center Interconnect, Optinet 2019, June 13, 2019, at 6, *available at* https://acacia-inc.com/wp-content/uploads/2019/06/Optinet-China-2019_Acacia_Fenghai-Liu_UpLoad_v1.pdf (highlighting digital "Impairment equalization" in Acacia's DCP ASIC for "Equalization of imperfections" in the signal path):



81. As discussed above, Acacia prominently markets its use of DSP technology to provide a "better algorithm to mitigate or compensate the penalty from those [photonic and RF]

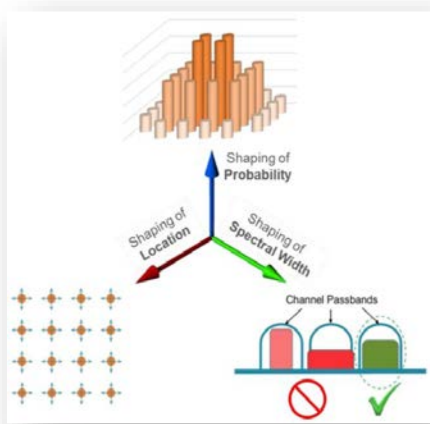
components.” *See, e.g.*, Video, Acacia Talks Coherent: Hongbin Zhang and Digital Signal Processing, *available at* https://acacia-inc.com/acacia-resources/acacia-talks-coherent-hongbin-zhang-and-digital-signal-processing/ (last accessed Feb. 4, 2022) (highlighting “3D Shaping” and “Non-linear compensation” as key benefits of Acacia’s DSP technology):

These techniques perform mapping in the digital domain that produce digital output patterns, such that the associated drive voltages as provided to the modulator alter the linearity of the optical response of the modulator—as compared to an unmapped providing of drive voltages associated with digital input values to the modulator. In so doing, these techniques perform the input to output mapping described in the claims of the Asserted Patent.

82. As an additional example, Cisco’s QSFP-40/100G-SRBD “BiDi” modules employ digital-to-digital mapping to perform a transmit pre-emphasis function. *See, e.g.*, Press Release: “Broadcom Announces Complete End-to-end Optical PAM-4 Platform for 40/100/200/400GbE Data Center Interconnects” (Mar. 21, 2016), *available at* https://investors.broadcom.com/news-releases/news-release-details/broadcom-announces-

complete-end-end-optical-pam-4-platform ("High efficiency laser driver with pre-emphasis function").

83. The Accused Products comprise the above-described system, wherein, within the digital-to-digital mapping, for a first subset of successively increasing digital input values specified in the digital-to-digital mapping, deltas between numerical values of successive digital outputs in the set of digital output values corresponding respectively to the successively increasing digital input values in the first subset, decrease. For example, and as described above, the digital signal processing of the Accused Products described herein maps digital input values to corresponding digital output values, in order to alter the optical response of the modulator. On information and belief, this mapping results in subsets of successively increasing digital input values for which the deltas between numerical values of the corresponding mapped digital outputs decrease. *See, e.g.*, Whitepaper, Optimize Network Utilization with 3D Shaping:



See also Video, Acacia Talks Coherent: Hongbin Zhang and Digital Signal Processing ("mitigate or compensate the penalty from those components" and "Non-linear compensation"); Presentation, Coherent Optical Solutions for Data Center Interconnect, Optinet 2019, June 13,

2019, at 8 ("Efficient EQ for non-perfect optics"), 6 ("Spectral shaping" and "Impairment equalization" in "Advanced DSP" for "Equalization of imperfections").

84. The Accused Products comprise the above-described system, wherein, within the digital-to-digital mapping, for a second subset of successively increasing digital input values specified in the digital-to-digital mapping, deltas between numerical values of successive digital outputs in the set of digital output values corresponding respectively to the successively increasing digital input values in the second subset, increase. For example, and as described above, the digital signal processing of the Accused Products described herein maps digital input values to corresponding digital output values, in order to alter the optical response of the modulator. On information and belief, this mapping results in subsets of successively increasing digital input values for which the deltas between numerical values of the corresponding mapped digital outputs increase. *See, e.g.*, evidence cited above.

85. By making, using, offering for sale, and/or selling products in the United States, and/or importing them into the United States, including but not limited to the Accused Products, Cisco (on its own and through its wholly owned subsidiary Acacia) has injured Ramot and is liable to Ramot for directly infringing one or more claims of the Asserted Patent, including without limitation claim 1, pursuant to 35 U.S.C. § 271(a).

86. Cisco (on its own and through its wholly owned subsidiary Acacia) also infringes the Asserted Patent under 35 U.S.C. § 271(b) & (c).

87. Cisco (on its own and through its wholly owned subsidiary Acacia) knowingly encourages and intends to induce infringement of the Asserted Patent by making, using, offering for sale, and/or selling products in the United States, and/or importing them into the United States, including but not limited to the Accused Products, with knowledge and specific intention

that such products will be used by its customers. As in the website postings, Blog posts, Presentations, Whitepapers, and Videos discussed herein, Cisco (on its own and through its wholly owned subsidiary Acacia) encourages and instructs its customers on how to use and implement the technology claimed in the Asserted Patent.

88. Cisco (on its own and through its wholly owned subsidiary Acacia) also contributes to the infringement of the Asserted Patent. Cisco (on its own and through its wholly owned subsidiary Acacia) makes, uses, sells, and/or offers to sell products in the United States, and/or imports them into the United States, including but not limited to the Accused Products, knowing that those products constitute a material part of the claimed invention, that they are especially made or adapted for use in infringing the Asserted Patent, and that they are not staple articles or commodities of commerce capable of substantial non-infringing use.

89. On information and belief, Cisco (on its own and through its wholly owned subsidiary Acacia) was aware of the Asserted Patent and related Ramot patents, had knowledge of the infringing nature of its activities, and nevertheless continues its infringing activities. Cisco has had notice of related predecessor Ramot patents and Ramot's allegations of infringement since at least April of 2014.

90. For example, on June 12, 2019, Ramot sued Cisco for infringement of Ramot patents related to the Asserted Patent. *See Ramot at Tel Aviv University Ltd. v. Cisco Systems, Inc.*, Case No. 2:19-cv-00225-JRG (E.D. Tex.), D.I. 1. Acacia participated in that lawsuit as a third party under subpoena.

91. Cisco defended against Ramot's assertion of certain claims of three of those related predecessor patents in Case No. 2:19-cv-00225-JRG through claim construction, discovery, expert discovery, dispositive motions, and pretrial preparations—before that case was

(and remains) stayed. Cisco also filed three unsuccessful *Inter Partes* Review petitions against these related predecessor Ramot patents, unsuccessfully appealed and sought a mandamus ruling from those unsuccessful IPR efforts, and then filed seven *Ex Parte* Reexamination petitions against these related predecessor Ramot patents.

92. In addition, on February 26, 2021, prior to Acacia's acquisition by Cisco, Ramot sued Acacia for infringement of related Ramot patents. *Ramot at Tel Aviv University, Ltd. v. Acacia Comm'ns, Inc.*, C.A. No. 21-295-LPS (D. Del.), D. I. 1.

93. In addition, Cisco filed a declaratory judgment action concerning another related predecessor Ramot patent (the '872 Patent) that had just issued. *Cisco Systems, Inc. and Acacia Communications, Inc. v. Ramot at Tel Aviv University Ltd.*, C.A. No. 21-1365-VAC (D. Del.). On information and belief, Cisco and Acacia followed the prosecution of the '872 Patent and prepared their declaratory judgment action prior to the patent issuing. For example, Cisco and Acacia filed their declaratory judgment action on the same day the '872 Patent issued, within hours of the patent issuing. Cisco has also filed two more *Inter Partes* Review petitions (IPR2022-00575 and IPR2022-00576) concerning the claims of the '872 Patent, which are pending.

94. In addition, on November 5, 2014, Ramot sued Cisco for infringement of two related predecessor patents of the Asserted Patent. *See Ramot at Tel Aviv University Ltd. v. Cisco Systems, Inc.*, Case No. 2:14-cv-1018 (E.D. Tex. Nov. 5, 2014), Dkt. 1 at ¶ 1. Cisco filed papers in that action, which was later voluntarily dismissed without prejudice. *Id.* at Dkt. 12, 16. In addition, related predecessor Ramot patents of the Asserted Patent were cited by and relied on by the patent examiner in at least one patent prosecution of a Cisco patent. *See* U.S. Patent No. 8,320,720 at 1.

95. Cisco's infringement of the Asserted Patent has been and continues to be deliberate and willful, and, this is therefore an exceptional case warranting an award of enhanced damages and attorneys' fees pursuant to 35 U.S.C. §§ 284-285.

96. As a result of Cisco's infringement of the Asserted Patent, Ramot has suffered monetary damages, and seeks recovery in an amount adequate to compensate for Cisco's infringement, but in no event less than a reasonable royalty with interest and costs.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff prays for judgment and seeks relief against Acacia as follows:

(a) For judgment that U.S. Patent No. 11,342,998 has been and continues to be infringed by Cisco;

(b) For an accounting of all damages sustained by Plaintiff as the result of Cisco's acts of infringement;

(c) For finding that Cisco's infringement is willful and enhancing damages pursuant to 35 U.S.C. § 284;

(d) For a mandatory future royalty payable on each and every future sale by Cisco of a product that is found to infringe the Asserted Patent and on all future products which are not colorably different from products found to infringe;

(e) For an award of attorneys' fees pursuant to 35 U.S.C. § 285 or otherwise permitted by law;

(f) For all costs of suit; and

(g) For such other and further relief as the Court may deem just and proper.

Dated: May 24, 2022

Respectfully Submitted,

By: /s/ *Corey Johanningmeier*

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